

PRINCIPLES OF WELDING

COURSE DESCRIPTION

Principles of Welding* is a course in which students will learn basics skills and knowledge related to cutting and welding applications. Welding and cutting skills will be developed in the context of a series of projects. Combined with the second year course, ***Welding Applications***, the student should be prepared for Entry Level Welding Certification, as defined by American Welding Society(AWS) QC10.

Prerequisite(s):

**Construction CORE*
Algebra I or Math for Technology II (may be concurrent)**

Recommended:

Engineering Design/CAD (may be concurrent)

Recommended Credits:

2

Recommended Grade Level(s): 10th or 11th

***This course may be offered as a part of the Construction or the Manufacturing Sub-Clusters, depending upon the student's career focus. Construction Core is required for students in the Construction Sub-Cluster, but it is not required for students in the Manufacturing Sub-Cluster if their instructors hold AWS certification.**

PRINCIPLES OF WELDING STANDARDS
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- 1.0 Students will demonstrate leadership, citizenship and teamwork skills required for success in the school, community, and workplace.
- 2.0 Students will read, comprehend, and communicate written and spoken technical specifications and instructions related to welding and welded assemblies.
- 3.0 Students will relate the properties of metals to weldments and the welding processes.
- 4.0 Students will interpret drawings and welding symbol information.
- 5.0 Students will safely store, operate, and maintain welding equipment and accessories.
- 6.0 Students will perform oxyfuel-cutting operations.
- 7.0 Students will make single-and multiple-pass fillet and groove welds using a shielded, metal arc welding (SMAW) process.

PRINCIPLES OF WELDING

STANDARD 1.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The student will:

- 1.1 Exhibit positive leadership skills.
- 1.2 Participate in SkillsUSA-VICA as an integral part of classroom instruction.
- 1.3 Assess situations and apply problem-solving and decision-making skills to particular client relations in the community, and workplace.
- 1.4 Demonstrate the ability to work cooperatively with others in a professional setting.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 1.1 Demonstrates character, leadership, and integrity using creative and critical-thinking.
- 1.2.A Applies the points of the creed to personal and professional situations.
- 1.2.B Participates and conducts meetings and other business according to accepted rules of parliamentary procedure.
- 1.3 Analyzes situations in the workplace and uses problem-solving techniques to solve the problem.
- 1.4.A Participates in a community service project.
- 1.4.B Assists with an officer campaign with Tennessee SkillsUSA-VICA.

SAMPLE PERFORMANCE TASKS

- Create a leadership inventory and use it to conduct a personal assessment.
- Participate in various SkillsUSA-VICA programs and/or competitive events.
- Evaluate an activity within the school, community, and/or workplace and project effects of the project.
- Implement an annual program of work.
- Prepare a meeting agenda for a SkillsUSA-VICA monthly meeting.
- Attend a professional organization meeting such as American Welding Society (AWS) chapter meeting.
- Participate in the American Spirit Award competition with SkillsUSA-VICA.
- Organize a partnership with a welding company in your local area.

INTEGRATION LINKAGES

SkillsUSA-VICA, *Professional Development Program*, SkillsUSA-VICA, *Total Quality Management*, SkillsUSA-VICA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Math, Math for Technology, Applied Communications, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills,

State Board of Education Approved
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Critical-Thinking Skills, SCANS (Secretary's Commission on Achieving Necessary Skills),
Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies
American Welding Society (AWS).

PRINCIPLES OF WELDING

STANDARD 2.0

Students will read, comprehend, and communicate written and spoken technical specifications and instructions related to welding and welded assemblies.

LEARNING EXPECTATIONS

The student will:

- 2.1 Demonstrate mathematical skills related to work assignments.
- 2.2 Read and demonstrate understanding of the welding terms and definitions from ANSI/AWS A3.0, *Standard Welding Terms and Definition*.
- 2.3 Complete a job assignment, given verbal work assignments.
- 2.4 Complete a job assignment, given written work assignments.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 2.1.A Adds, subtracts, multiplies, and divides whole numbers, fractions, mixed numbers, and decimals.
- 2.1.B Comprehends, demonstrates, and records measurements derived from using measuring devices.
- 2.1.C Analyzes the functions of angles and parts of a circle.
- 2.1.D Constructs parts using the principles of geometry.
- 2.1.E Reads and uses United States (U.S.) Customary and SI Metric tape, rule, and square.
- 2.2.A Locates information and solves problems by using forms.
- 2.2 Pronounces and uses welding terms in conversation and in written work.
- 2.3.A Completes assignments according to verbal instructions.
- 2.3.B Completes assignments in a timely manner.
- 2.3.C Carries out verbal instructions over the length of the program.
- 2.4.A Completes assignments according to written instructions.
- 2.4.B Completes assignments in a timely manner.
- 2.4.C Carries out written instructions over the length of the program.

SAMPLE PERFORMANCE TASKS

- Read, discuss, and develop a plan for following directions to complete a work assignment.
- Describe the work assignment task using welding terminology.
- Complete assignments using measuring devices and math skills.
- Use a calculator to perform basic arithmetic operations.
- Convert mixed number fractions to decimals and vice versa.
- Convert SI (metric) to U.S. (Customary) units and vice versa.
- Identify geometric shapes.
- Prior to beginning a project, verify that they've been checked out and approved for operation of that equipment.
- Demonstrate and practice proper use of protective equipment, hoods, leathers, clothing, etc. for the equipment used in a project.

- Appraise the work area for safety hazards and list common causes of typical accidents and injuries in the welding industry and outline a safety corrections program.
- Activate appropriate ventilation systems prior to beginning an operation.

INTEGRATION LINKAGES

Language Arts, Mathematics, Math for Technology, Applied Communications, Algebra, Geometry, SkillsUSA Technical Championships, American Welding Society (AWS), Guide for Training and Qualification of Entry Level Welder, National Center for Construction Education Research (NCCER), Secretary's Commission on Achieving Necessary Skills (SCANS), *Professional Development Program*, SkillsUSA-VICA, Occupational Safety and Health Administration (OSHA).

PRINCIPLES OF WELDING

STANDARD 3.0

Students will relate the properties of metals to weldments and the welding processes.

LEARNING EXPECTATIONS

The student will:

- 3.1 Evaluate the mechanical properties of metals and their importance in welding processes.
- 3.2 Analyze the thermal properties of metals and their effects on welding processes.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 3.1.A Compares and contrasts the meaning of tensile strength, hardness, elasticity, ductility, toughness, and brittleness.
- 3.1.B Describes the changes in mechanical properties of weldments that can occur during the welding process.
- 3.1.C Conducts destructive and non-destructive tests of mechanical properties of weldments.
- 3.2.A Describes and demonstrates techniques to mitigate the effects of thermal expansion and contraction that occur during welding processes.
- 3.2.B Explains the changes that can occur in the mechanical properties of weld and parent metals caused by the heating and cooling during welding.
- 3.2.C Compares the thermal conductivity of various metals, such as steel and aluminum, and explains effect of thermal conductivity on heat and cooling rates observed during welding.
- 3.2.D Compares the specific heats of various metals, such as steel and aluminum, and explains effect of specific heat on heat rates required for welding.

SAMPLE PERFORMANCE TASKS

- Make a field trip to a heat-treating facility.
- Make a field trip to a facility that manufacturers welded pipe.
- Make a field trip to a facility that manufacturers welded beams and trusses.
- Develop presentation or demonstration showing the mechanical and thermal properties of metals. Show results of comparisons of metals for tensile strength, hardness, elasticity, ductility, toughness, and brittleness. Explain the best use of each metal for various projects. Present the information to the school, community or professional organizations.

INTEGRATION LINKAGES

Language Arts, Mathematics, Math for Technology, Applied Communications, Algebra, Geometry, SkillsUSA Technical Championships, American Welding Society (AWS), Guide for Training and Qualification of Entry Level Welder, National Center for Construction Education Research (NCCER), Secretary's Commission on Achieving Necessary Skills (SCANS), Professional Development Program, SkillsUSA-VICA.

PRINCIPLES OF WELDING

STANDARD 4.0

Students will interpret drawings and welding symbol information.

LEARNING EXPECTATIONS

The student will:

- 4.1 Read and sketch drawings.
- 4.2 Identify basic weld symbols.
- 4.3 Identify lines and joints.
- 4.4 Differentiate between drawings and blueprints.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 4.1 Sketches parts and assigns measurements to the sketch.
- 4.2.A Evaluates welding symbol interpretation.
- 4.2.B Identifies fillet weld and v-groove.
- 4.3.A Labels objective, hidden, center, and break lines.
- 4.3.B. Labels butt, tee, lap, edge, and corner joints.
- 4.4.A Compares information on drawings and blueprints.

SAMPLE PERFORMANCE TASKS

- Examine and explain parts to determine application of symbols from drawings, sketches, and blueprints.
- Examine projects to distinguish various types of lines and joints.
- Keep records reflecting successful completion of assignments.

INTEGRATION LINKAGES

Writing and Communication Skills, Teamwork and Leadership Skills, Language Arts, Mathematics, Math for Technology, Applied Communications, Art, Blueprint Reading, Computer Skills, Internet Skills, Algebra, Geometry, SkillsUSA Technical Championships, American Welding Society (AWS), Guide for Training and Qualification of Entry Level Welder, National Center for Construction Education Research (NCCER), Secretary's Commission on Achieving Necessary Skills (SCANS), *Professional Development Program*, SkillsUSA-VICA, Occupational Safety and Health Administration (OSHA), Tennessee Occupational Safety and Health Administration (TOSHA).

PRINCIPLES OF WELDING

STANDARD 5.0

Students will safely store, operate, and maintain welding equipment and accessories.

LEARNING EXPECTATIONS

The student will:

- 5.1 Implement and comply with ANSI Z49.1, *Safety and Welding, Cutting, and Allied Processes and Occupational Safety and Health Administration (OSHA) requirements for operating each piece of equipment.*
- 5.2 Demonstrate required safety practices while operating all equipment and tools.
- 5.3 Exhibit acceptable dress and personal grooming as identified by the welding industry.
- 5.4 Demonstrate the use of basic metal working and welding equipment.
- 5.5 Evaluate the importance and use of ventilation.
- 5.6 Properly handle welding gas cylinders.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 5.1.A Passes with 100% accuracy a written safety examination relating to the applicable sections of ANSI Z49.1, *Safety and Welding, Cutting, and Allied Processes* and Occupational Safety and Health Administration (OSHA) requirements.
- 5.1.B Demonstrates compliance with ANSIZ49.1 as it relates to protection of personnel in the general area, ventilation, fire prevention and protection, precautionary information, and general aspects.
- 5.1.C Establishes and maintains a working environment incorporating the principles of ANSI Z49.1, *Safety and Welding, Cutting, and Allied Processes.*
- 5.1.D Analyzes fire prevention, electrical and safety methods to be incorporated with the use of welding equipment.
- 5.1.E Completes a safety inspection introducing Hazcom confined space and lockout/tagout implications.
- 5.2.A Maintain a portfolio record of equipment for which the student has passed an examination covering the operation of welding equipment and tools.
- 5.2.B Maintain a portfolio record of equipment for which the student has passed an operational checkout by the instructor.
- 5.3.A Compares and contrasts appropriate and inappropriate dress and personal grooming characteristics for specific jobs in the welding industry.
- 5.3.B Uses appropriate dress, eye/face protection, gloves, and other protective devices as required by ANSI Z49.1, *Safety and Welding, Cutting, and Allied Processes.*
- 5.4 Demonstrates grinding, sawing, and drilling operations within the tolerance specified on a drawing or blueprint.
- 5.5.A Uses ventilating equipment, safety shields, and curtains as required by ANSI Z49.1, *Safety and Welding, Cutting, and Allied Processes.*
- 5.5.B Develops and administers formative or diagnostic tests for proper ventilation.
- 5.6.A Stores welding gas cylinders in an upright and secure position.
- 5.6.B Operates with welding gas cylinders in an upright and secured position.
- 5.6.C Installs cylinder caps immediately upon removal of gauges from welding gas cylinders.

SAMPLE PERFORMANCE TASKS

- Write a report on potential skin and eye damage caused by ultraviolet radiation produced by arc welding processes.
- Participate in a job interview where a portfolio is used to show welding equipment and tools that the student has received an operational checkout by the instructor and grades on written examinations of the operation of welding equipment and tools
- Look up MSDS for welding fluxes, shielding compounds, and filler materials to assess the risks of toxic gas release and acidity in the school welding shop.
- Demonstrate the proper handling and transportation of compressed gas cylinders.
- Demonstrate proper use of protective equipment, hoods, leathers, and clothing.
- Simulate use of fire extinguisher.
- Appraise the work area for safety hazards and list common causes of typical accidents and injuries in the welding industry. Based on the findings of the appraisal, outline a safety corrections program and present the program to the school and professional organizations.
- Cut, saw, and drill holes in metal.

INTEGRATION LINKAGES

Language Arts, Mathematics, Math for Technology, Applied Communications, Algebra, Geometry, SkillsUSA Technical Championships, American Welding Society (AWS), Guide for Training and Qualification of Entry Level Welder, National Center for Construction Education Research (NCCER), Secretary's Commission on Achieving Necessary Skills (SCANS), *Professional Development Program*, SkillsUSA-VICA.

PRINCIPLES OF WELDING

STANDARD 6.0

Students will perform oxyfuel-cutting operations.

LEARNING EXPECTATIONS

The student will:

- 6.1 Prepare layouts for cutting individual parts.
- 6.2 Perform cuts using oxyfuel gas-cutting process.
- 6.3 Use weld-washing techniques.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 6.1.A Utilizes rulers, straightedges, chalklines, and other layout equipment to make a layout suitable for guiding a cutting operation.
- 6.1.B Uses principles of algebra and geometry to assist in complex layout operations.
- 6.2.A Cuts straight parts using the oxyfuel gas-cutting process.
- 6.2.B Cuts shaped parts using the oxyfuel gas-cutting process.
- 6.2.C Cuts beveled parts using the oxyfuel gas-cutting process.
- 6.3.A Removes tack welds using weld-washing techniques.
- 6.3.B Washes out the defective weld material.

SAMPLE PERFORMANCE TASKS

- Prepare a layout of a rectangular part and verify squareness of the layout by measuring diagonals.
- Prepare a layout of an acute angle using linear measurements and trigonometric relationships.
- Prepare a layout for an elliptical part when given dimensions of the major and minor axes.
- Using oxyfuel flame-cutting equipment, cut metal plate parts for the assembly of a rectangular metal tank.
- Using oxyfuel flame-cutting equipment, cut metal plate parts for the assembly of a silhouette metal sign.
- Using oxyfuel flame cutting equipment, cut a length of metal pipe, beveling the ends for the purpose of joining the pipe with groove welds.
- Identify a faulty alignment in a tack-welded assembly, use weld-washing techniques to remove the tack weld, and correct the alignment.

INTEGRATION LINKAGES

Writing and Communication Skills, Teamwork and Leadership Skills, Language Arts, Mathematics, Math for Technology, Applied Communications, Art, Blueprint Reading, Computer Skills, Internet Skills, Algebra, Geometry, SkillsUSA Technical Championships, American Welding Society (AWS), Guide for Training and Qualification of Entry Level Welder, National Center for Construction Education Research (NCCER), Secretary's Commission on Achieving Necessary Skills (SCANS), *Professional Development Program*, SkillsUSA-VICA, Occupational Safety and Health Administration (OSHA), Tennessee Occupational Safety and Health Administration (TOSHA).

PRINCIPLES OF WELDING

STANDARD 7.0

Students will make single-and multiple-pass fillet and groove welds using a shielded, metal arc welding (SMAW) process.

LEARNING EXPECTATIONS

The student will:

- 7.1 Make single-and multiple-pass fillet and groove welds in the flat position.
- 7.2 Make single-and multiple-pass fillet and groove welds in the horizontal position.
- 7.3 Make single-and multiple-pass fillet and groove in the vertical position.
- 7.4 Make single-and multiple-pass fillet and groove welds in the overhead position.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 7.1.A Makes a single-pass fillet weld on plain carbon steel in the flat position.
- 7.1.B Makes a multiple-pass fillet weld on plain carbon steel in the flat position.
- 7.1.C Makes a single-pass groove weld on plain carbon steel in the flat position.
- 7.1.D Makes a multiple-pass groove weld on plain carbon steel in the flat position.
- 7.2.A Makes a single-pass fillet weld on plain carbon steel in the horizontal position.
- 7.2.B Makes a multiple-pass fillet weld on plain carbon steel in the horizontal position.
- 7.2.C Makes a single-pass groove weld on plain carbon steel in the horizontal position.
- 7.2.D Makes a multiple-pass groove weld on plain carbon steel in the horizontal position.
- 7.3.A Makes a single-pass fillet weld on plain carbon steel in a vertical position.
- 7.3.B Makes a multiple-pass fillet weld on plain carbon steel in a vertical position.
- 7.3.C Makes a single-pass groove weld on plain carbon steel in a vertical position.
- 7.3.D Makes a multiple-pass groove weld on plain carbon steel in a vertical position.
- 7.4.A Makes a single-pass fillet weld on plain carbon steel in an overhead position.
- 7.4.B Makes a multiple-pass fillet weld on plain carbon steel in an overhead position.
- 7.4.C Makes a single-pass groove weld on plain carbon steel in an overhead position.
- 7.4.D Makes a multiple-pass groove weld on plain carbon steel in an overhead position.

SAMPLE PERFORMANCE TASKS

- Complete projects to enhance the learning activity. Integrate related academic skills and knowledge to design, layout, and fabricate a welding project.
- Practice for the Entry-Level Welder Certification.

INTEGRATION LINKAGES

Language Arts, Mathematics, Math for Technology, Applied Communications, Algebra, Geometry, SkillsUSA Technical Championships, American Welding Society (AWS), Guide for Training and Qualification of Entry Level Welder, National Center for Construction Education Research (NCCER), Secretary's Commission on Achieving Necessary Skills (SCANS), Professional Development Program, SkillsUSA-VICA.

PRINCIPLES OF WELDING

SAMPLING OF AVAILABLE RESOURCES

American Welding Society (AWS) Educators' Web site: **<http://www.aws.org/Educators/>**
(includes AWS Educator's Library online and downloadable *Engineering Your Future* Teacher's Guide.)

American Welding Society (AWS), *Guide for Training and Qualification of Entry Level Welder*.

Andrew D. Althouse, Carl H. Turnquist, William A. Bowditch and Kevin E. Bowditch. *Modern Welding*. Goodheart Willcox 2000. www.goodheartwillcox.com

William A. Bowditch and Kevin E. Bowditch. *Welding Technology Fundamentals*. Goodheart Willcox 1997. www.goodheartwillcox.com

James A. Ruck. *Welding Projects*. Goodheart Willcox 1999.

Introduction to Welding Video Series. Glencoe 1998. www.glencoe.com

Wheels of Learning Standardized Craft Training Guide-Welding, Level I, Prentice Hall 1996

National Center for Construction Education Research, NCCER. www.nccer.org